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XIX.

ON THE USE OF THE ELECTRIC TELEGRAPH DURING TOTAL SOLAR ECLIPSES.

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Presented January 12, 1881.

ONE of the most intractable considerations in the study of the sun and its surroundings lies in the small amount of time which is available for the prosecution of that study. Most of the phenomena in the neighborhood of the sun can be investigated only when the sun itself is hidden during eclipse. If we suppose a single observer to be prepared for the observation of all the total solar eclipses of a century, we shall find that the entire amount of time during which he may contemplate the totally eclipsed sun will not differ much from an hour. We may be sure, then, of the expediency of any scheme whereby the rare moments of these eclipses may be utilized to their utmost extent. If such scheme is devised, two important results are like to follow: —

(1) Economy of the sum-total of energy in any particular line of solar research.

(2) A consequent enlargement of the means of research in other directions.

The general conception of the scheme proposed in this paper may be very briefly stated: Suppose a station to the east and a station to the west on the line of any total eclipse, as widely separate as practicable, and equipped for similar observations of discovery during the progress of the eclipse: the method proposes the electro-telegraphic transmission of important observations made at the western station to observers at the eastern station, with due speed for their verification or rejection when the lunar shadow reaches the latter station.

For illustration, consider the next total eclipse, — that of 1882, May 16. In detail, the particular advantages in connection with this eclipse seem to be about these: —

(1) The path of totality is almost exclusively on land. Central eclipse begins in West Africa; the line of totality passes to the northeast, crossing Upper Egypt, and the Nile at El-Akhmym; thence over the Red Sea, crossing the Tigris a few miles to the south of Bagdad; then passing a little to the south of Teheran, it traverses Central Asia, and leaves the Asiatic continent somewhat to the north of Shanghai.

(2) Though not generally through the inhabited regions of the globe, the path of totality lies through several inhabited regions which are widely separate; viz., Egypt near the Nile, Central Persia, and Eastern China.

(3) These regions are inter-connected by telegraphic cables and land-lines. From El-Akhmym a land-line runs to the north along the banks of the Nile, and thence to Diarbekir and Constantinople,—from either of which Teheran, the capital of Persia, is readily accessible by telegraph. From Teheran, a land-line runs southeast through Persia, Beluchistan, and Hindostan to Madras; and from thence cable-lines extend through Singapore and Hong-Kong to Shanghai. An additional advantage attaches to this eclipse-line from there being a duplicate line of connection by telegraph between El-Akhmym and Shanghai: it would be advisable that any message of discovery at the former station should be repeated over this duplicate line, — from Constantinople, to Vienna, to Warsaw, to Moscow, and thence through the Russian overland line extending across Siberia to Wladiwostok, to Nagasaki, and Shanghai. The through-transmission of the message might then be secured beyond doubt.

Now, we will suppose that an important observation of discovery is made at El-Akhmym, — an observation of an intramercurial planet, for example. Between forty and forty-five minutes of absolute time elapse before totality comes on at Teheran. During this interval, the observer at El-Akhmym will have an abundance of time for transcribing the apparent magnitude and the precise position of the new body, and transmitting the same to his fellow-observer at Teheran several minutes before the lunar shadow reaches him. The latter observer will then have leisure to proceed with the setting of his circles, the verification of their readings, and the pointing of his instrument to the precise part of the heavens indicated. He may then be able to see the suspected object before the eclipse becomes total. He may also decide upon a neighboring star for comparison with the planet, and thus obtain a very accurate determination of its position. The observer at Teheran should also be prepared for an independent search for the suspected planet, in the event of receiving a negative message from the observer at El-Akhmym.

The observation at El-Akhmym should also be transmitted to Shanghai (reached by the shadow more than two hours after totality at Teheran), for independent verification at that point. We might thus observe the result of nearly three hours' motion of the planet, — which we might reasonably expect to give important data in regard to its orbit about the sun. Of course, the result of the observations at Teheran would also be transmitted to the observer at Shanghai.

It was my intention, primarily, to have considered the total eclipse of 1882 merely as an illustration of the method proposed. Further investigation, however, seems to show that it is at least one of the two most favorable eclipses during the present decade, if not during the present century. A few additional considerations merit attention: —

(1) Accessibility of the observing-stations. El-Akhmym, on the Nile, is only two or three days from Cairo, and nearly the whole journey may be made by rail. By steamer on the Nile, the journey is something like two days longer. Teheran, in so far as I have been able to ascertain, is not difficult of access, though most of the journey must be by caravan-routes, and very little by rail. Of the accessibility of Shanghai, nothing need be said.

(2) Some doubt may exist with regard to the possibility of telegraphic transmission with sufficient celerity, owing to the necessary number of repetitions of the messages. As for the lines from Egypt to Teheran, and from Egypt to China, the matter will seem less embarrassed from the fact that these lines are largely under the same control. Three quarters of an hour seems an abundance of time for the transmission of an imperative message from Egypt to Shanghai, allowing five or six repetitions of the message on the way. Of course, the success of the scheme will rest largely with the thoroughness of preconcerted arrangement. The generous courtesy hitherto shown astronomers by the officials in charge of telegraphic lines encourages the belief that they would be disposed to do everything in their power on such an occasion.

(3) The cloudiness of the stations. The chances of clear weather in Upper Egypt in the middle of May appear to be very good. I have pleasure in thanking Mr. Cleveland Abbe, of the office of the Chief Signal Officer of the Army, for his references in this matter. From observations at Alexandria in the month of May, of the years 1870–74, the following results are obtained: —

Mean cloudiness, 1.7.
Number of rainy days, one in five years.
Number of totally cloudy days, one in five years.
Number of wholly clear days, 21 each May.

Up the Nile, as far as El-Akhmym, the conditions would be a little less favorable. With Bagdad and Teheran in the month of May, the case stands very similar.

There are no readily available records with regard to the cloudiness of Shanghai.

(4) The duration of totality of the eclipse of 1882 is not very favorable. At El-Akhmym totality lasts one minute and twelve seconds. At Teheran the eclipse is total something like one minute and two tenths. And at a point a few miles to the north of Shanghai, the duration of totality is nearly half a minute; but this short interval would suffice for the purpose of verification simply.

We may examine the conditions of applicability of the telegraphic method to total eclipses subsequent to that of 1882: —

a. — The total eclipse of 1883, May 6. The path of totality lies almost entirely on water, beginning to the east of Australia, and going between New Caledonia and New Zealand, and leaving the earth to the west of South America. In the longitude of the Marquesas Islands, the duration of totality is about five minutes and fifty seconds, but there is no other station where the eclipse will be observable on land.

b. — The total eclipse of 1885, September 8. In the longitude of Wellington, New Zealand (the south point of the north island), the duration of totality is one minute and fifty-four seconds. It does not appear, however, that telegraphic communication with any other station will be practicable.

c. — The total eclipse of 1886, August 29. Here again we have an ocean-track except for a few miles at the beginning, and a small portion at the end. In Grenada the duration of totality is three minutes and fifteen seconds; on the Atlantic Ocean, off the coast of Liberia, six minutes and thirty seconds; and on the western coast of Africa (latitude 12° south), about four minutes and forty-five seconds. The time of the eclipse, however, is the storm-season in the West Indies; so that we are not warranted in expecting very much of this eclipse, notwithstanding the extraordinary duration of totality.

d. — The total eclipse of 1887, August 18. The totality-path of this eclipse begins in central Germany, and passes to the north of Moscow, where the duration of totality is two minutes and thirty seconds. It then follows approximately the course of the Russian overland telegraphic line, and crosses Lake Baikal, where the duration of totality is three minutes and thirty-eight seconds. This eclipse will, therefore, be even more favorable than that of 1882 for the application of the telegraphic method.

e. — The total eclipse of 1889, December 22. The track of this eclipse is similar to that of 1886. At Bridgetown, Barbadoes, totality lasts one minute and forty-eight seconds. On the west coast of Africa (latitude 10° south), three minutes and thirty-four seconds. It seems probable that the method will not be applicable to this eclipse.

An acknowledgment is due the editor of the astronomical notes in *Nature* for the greater part of the data relating to the eclipses which I have cited.

WASHINGTON, January 8, 1881.